INVESTIGATING FACTORS AFFECTING THE FORWARD PRICING BEHAVIOUR OF VAALHARTS MAIZE PRODUCERS: A TWO-STEP ECONOMETRIC APPROACH

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Abstract

A two-step econometric approach is employed to investigate the factors that influence the forward pricing behaviour of Vaalharts maize producers. The first step is to analyse the adoption decision with a binary sub-model, while the second step is to model the quantity decision, conditional of the adoption decision, in a linear sub-model. Based on the results, two distinct sets of variables influence the two decisions. The adoption of forward pricing is associated with higher levels of human capital, while the quantity decision is mainly driven by farmers' risk attitudes and their perceptions of forward pricing in price risk management. Since two sets of variables influence the two decisions, it is insufficient to educate farmers only on the benefit of using forward pricing methods. Such education does not empower farmers to use these tools. Future research and education should emphasise on how much to contract, which type of contract to use, and the frequency of contracting.

Keywords: *forward pricing, risk management, regression*

Introduction

Product price variability has increased substantially after the deregulation of the South African marketing boards in the mid 1990's (Groenewald *et al*., 2003). Since the variability in product prices is a major component of the variability in profit, the importance of price variability to a farm business is clear. South African maize producers can hedge[1] against price risk on the South African Futures Exchange (SAFEX), or they can use cash forward contracts[2] to sell their crops. The use of these two mechanisms is generally known as forward pricing.

Ample research was done on farmers' use of forward pricing methods in price risk management. The common finding in both international research (Asplund *et al*., 1989; Goodwin and Schroeder, 1994; Musser *et al*., 1996; Sartwelle *et al*., 2000; Issengildina and Hudson, 2001; and Katchova and Miranda, 2004), and South African research (Bown, 1999; and Jordaan and Grovè, 2007), is that few farmers use forward pricing methods to manage price risk.

The low use of forward pricing, however, is not the only concern. Those farmers who do use forward pricing methods forward price at a lower level than what is prescribed in optimal hedging research. Although different researchers found different optimal hedge ratios[3], the common conclusion is that a farmer should forward price a large proportion of his/her crop. The prescribed ratio lies between 55% and

[1] Hedging is the process where the maize producer trades futures contracts as a substitute for a cash market transaction in anticipation of a future harvest. A futures contract is a type of forward contract with highly standardised and closely specified contract terms, and always trades on an organised exchange (Kolb, 2003).
[2] A cash forward contract involves a contract that is initiated at one time, and the performance in accordance with the terms of the contract (payment and delivery) occurs at a subsequent time (Kolb, 2003). Contrary to a futures contract, a cash forward contract does not trade on an organised exchange. In this paper, cash forward contracting refers to any form of forward pricing that is not done through the South African Futures Exchange.
[3] The proportion of the crop which is forward priced.

90% (Alexander *et al*., 1986; Grant, 1988; and McNew as cited by McNew and Musser, 2000). Musser *et al*. (1996); Shapiro and Brorsen (1998); and Sartwelle *et al*. (2000) investigated the levels to which farmers use forward pricing methods. Except for the study by Musser *et al*. (1996), respondents in all the other studies cash forward contracted less than 30%, and hedged less than 20% of their crops. Clearly these values are substantially lower than the values that are prescribed in optimal hedging research.

Although a large volume of research has been done to study forward pricing behaviour, Katchova and Miranda (2004) argue that some of those studies suffer from a common shortcoming. Some studies modelled the adoption and quantity decisions simultaneously, which implicitly assume that personal and business characteristics influence the adoption and quantity decision in both the same direction, and to the same level. Such an assumption is generally not reasonable. Recommendations based upon such research, furthermore may not have the desired impact on the use or forward pricing as a price risk management tool. Katchova and Miranda (2004) proposed the use of a two-step econometric procedure to overcome the shortcomings of the other methods. The first step the model captures the characteristics which influence the adoption decision in a binary sub-model. Then, conditional to the farmer decided to use forward pricing methods, the second step captures the characteristics that influence the decision of the quantity to be forward priced in a conditional truncated sub-model. The use of a two-step model for the adoption of forward pricing and the quantity forward priced, thus, do not force the same variables to influence the two decisions, and to influence both decisions in the same direction. The main purpose of this research is to compare the factors that influence the decision whether or not to adopt forward pricing, and the decision on the level to which a farmer is willing to use forward pricing methods. The objective is achieved by employing the proposed two-step econometric procedure. The adoption decision is modelled with logistic regression, while the quantity decision is modelled, conditional of the adoption decision, with Ordinary Least Squares (OLS) linear regression.

The remainder of the paper is structured as follows. Section 2 covers the data and procedures used to meet the objective of the study, while the results are presented and discussed in Section 3. Finally, some conclusions are drawn and recommendations made in Section 4.

Data And Procedures

Data

A questionnaire survey was conducted in the Vaalharts irrigation scheme during October 2005 to obtain primary data regarding the personal and business characteristics of farmers, and their marketing behaviour. Seventy eight farmers were randomly drawn and personally interviewed to complete the questionnaire. Only 50 of those farmers produced maize during the 2004/05 season and were analysed further.

Based on the information obtained with the questionnaire, maize producers indicated that they have, on average, 22 years of farming experience, and an average age of 50 years. Marginally more than half of the sample of maize producers completed some form of tertiary education. They are, on average, willing to sacrifice 16.38% of their current expected yield for the opportunity to produce a crop with a constant yield. This proportion is called the respondent's yield risk premium and is used as a proxy for his/her level of risk aversion (Musser *et al*., 1996). Respondents seem to be relatively well diversified, with an average index of 0.31 for the level of specialisation[4], and 58% of them use centre pivot irrigation technology, which is more advanced than flood irrigation.

[4] The level of specialisation was determined by summing the squared proportions of each enterprise's contribution to total farm income. A score of 1 indicates the specialisation in the production of only 1 crop (Nieuwoudt, 1998).

Procedures

The first step of the two-step procedure is to model the adoption decision using binary logistic regression. In the second step, OLS linear regression is used to model the quantity decision conditional to the adoption decision.

Logistic regression of the factors influencing the adoption decision

Binary logistic regression requires a binary dependent variable. The dependent variable in the first step is the binary choice whether or not the respondent used forward pricing methods to market his/her 2004/05 maize crop. Respondents who used forward pricing methods were given a value of one, (irrespective of whether the participation was direct or indirect[5]) and the others a value of zero. Twenty -two (44%) of the fifty respondents used forward pricing methods, of which only two (4%) used futures contracts. Not a single respondent used options.

The logit model may be expressed as:

$$\phi_i = E(y_i = 1|X_i) = \frac{1}{1 + e^{-\left(\beta_i + \sum_i^k \beta_j x_i\right)}}$$

Where: ϕ_i is the probability of respondent *i* using forward pricing strategies, y_i is the observed use of forward pricing by respondent *i*, x_i are the factors which determine the use of forward pricing by respondent *i,* and B_j stands for the parameters to be estimated.

OLS regression of the factors influencing the quantity decision

The second step of the two-step procedure captures the characteristics that influence the decision on the quantity to be forward priced. Recall that this decision is analysed conditional to the respondents having used forward pricing methods, and therefore only 22 respondents were included in the analysis. The quantity forward priced is a continuous dependent variable which suggests that OLS regression can be used to model the quantity decision. The OLS model may be expressed as:

$$Y_i = \beta_0 + \beta_j X_j + \varepsilon$$

Where Y_i is the proportion of his/her crop which farmer *i* forward priced, β_j are the parameters to be estimated, and X_j are the factors which influence the proportion of his/her crop the farmer is willing to forward price.

Hypothesised explanatory variables

Table 1 shows the explanatory variables that were hypothesised to influence the adoption and quantity decisions, as well as the expected direction of the influence. The same variables are hypothesised to influence the two decisions, and also to influence both decisions in the same direction.

[5] Indirect hedging is when the farmer's consultant used forward pricing methods to market the crop on behalf of the farmer.

Table 4: Variables expected to influence the forward pricing behaviour of Vaalharts maize producers and the expected direction of the influence

Variable	Definition	Expected sign
EXP	Number of years of farming experience the respondent has	+/-
MKTSKLL	Respondent's self-rating of his/her marketing skills relative to that of other farmers in the region (measure on scale from 1 (much lower) to 7 (much higher)).	+/-
OFFECON	Proportion of total income that was generated from off-farm economic activities (%).	+/-
INSUR	Dummy variable scoring 1, if respondent used crop insurance, 0 otherwise.	+/-
SPECIAL	Level of specialisation (index compiled by summing the squared proportional contributions of all enterprises to the total farm income. A value of 1 indicates the specialisation in the production of 1 crop.)	+/-
CP	Dummy variable scoring 1, if respondent adopted centre pivot technology, 0 otherwise.	+/-
EDU	Dummy variable scoring 1 if respondent has some form of tertiary education, 0 otherwise.	+
RISKAVER	Level of risk aversion measured by means of a yield risk premium (Proportion of current expected yield that respondent is willing to sacrifice for opportunity to produce crop with constant yield).	+
FWDPERC	Dummy variable scoring 1, if respondent perceives forward pricing to be effective in reducing price risk, 0 otherwise.	+
FREEMKTPREF	Rating of respondent's preference for a free market rather than a market regulated by government on a scale from 1 - 7 with 7 indicating a 100% preference for the free market.	+
PROPRENT	Proportion of farmland that is rented (%).	+

The direction of the influence of a number of the explanatory variables hypothesised to affect forward pricing behaviour, are ambiguous. More years of farming experience (EXP) is normally associated with a healthier financial position. Davis (2005) suggested that a person in a healthier financial position is more likely to use forward pricing methods. Producers with higher levels of marketing skills (MKTSKLL) are expected to be more comfortable to use forward pricing methods (Isengildina and Hudson, 2001). On the contrary, however, a person who does not rate his/her marketing skills highly is more likely to use consultancy services to make marketing decisions. The consultant, however, is more likely to use forward pricing methods. The use of other risk management tools is also hypothesised to influence forward pricing behaviour, since it affects the overall risk of farmers' enterprises and asset investments (Bown *et*

al., 1999). The direction of the expected influence depends on whether the risk management tool is used complimentary to forward pricing (positive) or as a substitute for it (negative). Risk management tools considered in this study include off farm economic activities (OFFECON), crop insurance (INSUR), diversification (the inverse of SPECIAL), and the adoption of centre pivot irrigation technology (CP). Since the use of risk management tools can be used complimentary to forward pricing, or as a substitute for it, the expected directions of the influence of the above variables are ambiguous.

Other variables hypothesised to affect the use of forward pricing positively include formal education (EDU), risk aversion (RISKAVER), the decision maker's perception of forward pricing as a risk management tool (FWDPERC), his/her preference for the free market system (FREEMKTPREF), and the proportion of farmland that is rented (PROPRENT). According to Goodwin and Schroeder (1994) more educated farmers are more likely to adopt new technology, and therefore forward pricing. McNew and Musser (2000) argued that risk aversion becomes the primary motive for farmers to use forward pricing methods. A person who perceives forward pricing to be effective in reducing price risk is expected to be more likely to use forward pricing methods (Isengildina and Hudson, 2001). Similarly, a person who prefers the free market system to a market which is regulated by government is also expected to be more likely to use forward pricing methods. Finally, a person who rents a large proportion of his/her farmland incurs a fixed cost which has to be met regardless of the price he/she receives for the crop. Such a person, thus, is expected to be more likely to use forward pricing methods to manage price risk. The results are presented and discussed next.

Results and Discussion

The results from the logistic regression of the factors affecting the adoption decision, and the OLS regression of the factors affecting the quantity decision, are presented in Table 2. The partial effects of the variables in the logistic regression are omitted and only the signs of the coefficients of the respective variables are interpreted. The interpretation only of the signs of the coefficients is deemed to be sufficient since the aim of the logistic regression is only to identify the factors which significantly influence the adoption decision, and the direction of the influence.

Table 5: Regression results of the factors affecting forward pricing behaviour of Vaalharts maize producers

	Logistic regression Coefficient (Adoption decision)	OLS regression Coefficient (Quantity decision)
Intercept	-7.7047*	65.2090*
RISKAVER	-0.0584*	0.4540**
PROPRENT	2.9896*	NA[1]
CP	2.4124*	NA
MKTSKLL	0.6578***	NA
SPECIAL	6.9422**	-152.1400*
INSUR	1.6411***	30.8740**
FREEMKTPREF	NA	3.6030**
OFFECON	NA	-0.4390*
FWDPERC	NA	20.5790**
GOODNESS OF FIT		
Percentage correctly predicted (%)	72	
McFadden R-Squared[2]	0.3011	
LR-statistic[3]	7.1290	
Probability(LR stat)[4]	0.007	
F-test		6.1680
Prob(F)		0.0547
R^2		0.7870
Adjusted R^2		0.6600

*Note: *, **, and *** indicate statistical significance of 5%, 10%, and 15%, respectively.*

[1] *"NA" indicates that the variable does not significantly influence the specific decision*

[2] *McFadden R-Squared is an analog to the R^2 reported in linear regression models*

[3] *LR-statistic is the analog of the F-statistic in linear regression models and tests the overall significance of the model.*

[4] *Probability(LR stat) is the p-value of the LR test statistic*

Both the logit and OLS models prove to be a good fit. Except for the McFadden R-Squared value of the logit model, all the goodness of fit measures suggests that the developed model is a good fit. The McFadden R-Squared value of 0.3011 may seem low, however, it is consistent to the findings of Sartwelle *et al*. (2000) (0.108) and Katchova and Miranda (2004) (0.36).

From the results presented in Table 2 it is clear that the variables influence the two decisions separately. Thus, the suggestion by Katchova and Miranda (2004) to model the adoption and quantity decisions separately is supported.

It is interesting that risk aversion (RISKAVER) ($p<0.05$) influence the adoption decision negatively. The negative influence implies that a risk averse farmer is less likely to adopt forward pricing methods. Although the negative influence is the opposite from what was expected, it is consistent to the findings of Goodwin and Schroeder (1994); Musser *et al*. (1996); and Sartwelle *et al*. (1999). The negative

relationship between risk aversion and the adoption of forward pricing may be an indication that respondents do not perceive forward pricing to be effective in price risk management, that respondents may perceive forward pricing as a risky marketing alternative, or they may perceive it as a tool to increase their income rather than to manage risk. The influence of risk aversion ($p<0.10$) on the quantity decision, however, is positive. The result is consistent with theory because decision-makers are expected to forward price a larger proportion of his/her crop as their risk aversion increases. The fact that such an important variable influence the two decisions in opposite directions emphasise the importance to model the two decisions separately.

Another interesting finding is the combination of factors which were found to significantly influence the adoption of forward pricing methods. Those variables include specialised crop production (SPECIAL), use of centre pivot irrigation technology (CP), the proportion of farmland rented (PROPRENT), and marketing skills (MKTSKLL). All those variables are associated with higher levels of human capital. A farmer who specialises in production activities is also expected to specialise in marketing activities, due to the fact that the specialisation may indicate the person's preference to be on the cutting edge of business activities. Specialisation in these activities requires higher levels of human capital. Compared to flood irrigation, centre pivot irrigation is more sophisticated. The higher level of sophistication requires a higher level of managerial skills to optimally benefit from the more sophisticated technology. It is also expected that only the prosperous farmers will rent additional farmland. The more prosperous farmers are expected to have higher levels of management skills, and hence human capital. Finally, the relationship between higher levels of marketing skills and human capital is self explanatory. From the above it is concluded that the adoption of forward pricing is associated with higher levels of human capital, and therefore with a certain type of person. That certain type of person is one who possesses entrepreneurial characteristics, which implies that there is some evidence that forward pricing is associated with entrepreneurial behaviour.

When investigating the affect of human capital on the quantity decision, except for the level of specialisation, none of the above variables significantly influence the quantity decision. Thus, there is no evidence that the quantity decision is driven by human capital. Again the difference between the factors which influence the two decisions is clear. Due to the fact that human capital only influence the adoption decision, it is important to determine the factors which drive the quantity decision. Apart from risk aversion which is identified as an important factor affecting the quantity decision, the results show also that the use of alternative risk management tools significantly influence the quantity decision. The directions of the influence of those risk management tools differ. Thus, by implication, some are used complimentary to forward pricing (those with positive signs), while the others are used to substitute for it (those with the negative signs). Vaalharts maize producers tend to use diversification ($p<0.05$), which is the inverse of SPECIAL, and crop insurance (INSUR) ($p<0.10$) complimentary to forward pricing, and off farm economic activities (OFFECON) ($p<0.05$) to substitute for it. Since producers tend to use multiple risk management tools, it may be an indication that they are risk averse. Together with the fact that risk aversion was found to positively influence the quantity decision, the fact that respondents use multiple risk management tools complimentary to forward pricing, suggests that risk aversion is the primary driver of the quantity decision.

Two of the hypothesised variables influence only the quantity decision. These variables are the preference for the free market system (FREEMKTPREF) ($p<0.10$) and the perception of farmers that forward pricing is an effective risk management strategy (FWDPERC) ($p<0.10$)). Interesting is that both these variables are based upon perceptions, which suggest that farmer perceptions also influence the quantity decision. Thus, the improvement of farmers' perceptions of forward pricing in price risk management is important to increase the level to which they are willing to use forward pricing methods.

From the above it is clear that different variables influence the adoption and quantity decisions with regard to forward pricing behaviour. The next section covers the conclusions that were drawn from this

study and some recommendations made for future research and education in the use of forward pricing methods to manage price risk.

Conclusions and Recommendations

The major conclusion from this study is that different variables affect the adoption and quantity decisions. It is therefore imperative to model the two decisions separately, which supports the suggestion by Katchova and Miranda (2004).

The adoption of forward pricing is associated with higher levels of human capital and entrepreneurial behaviour, while the quantity decision is mainly driven by the farmers' levels of risk aversion and the perception that forward pricing is an effective risk management strategy. Results from the logit analysis furthermore indicated that Vaalharts maize producers may perceive forward pricing to be ineffective to manage price risk, which was also found by Jordaan and Grovè (2007) who performed a factor analysis on the personal factors restricting farmers to use forward pricing methods. Although risk aversion was found to be the main driver of the quantity decision, good perceptions of forward pricing also influence the level to which they use forward pricing methods. Thus, it is clear that farmers' perceptions need to be improved in order to increase both the adoption of forward pricing, and the levels to which they use forward pricing methods in price risk management.

The fact that there exist two distinct sets of variables that influence the adoption and quantity decisions has some serious implications for research and extension. Farmers should not only be made aware of the benefits of forward pricing in price risk management; they should also be empowered to use these tools effectively. Education in the benefits of forward pricing may increase the rate of adoption while not the level to which a farmer will forward price. Thus, future research and education should place more emphasis on how much to contract, which type of contract to use, and to identify the frequency of contracting.

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